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COAL MINE METHANE USE IN FUEL CELLS

200 kW Phosphoric-acid fuel cell (PAFC) with a thermal output of 700,000 Btu/hr
Unit dimensions = 10ft x 10ft x 18ft. (Photo courtesy of International Fuel Cells)

COAL MINE METHANE POWERED FUEL CELLS CAN...

- Operate on methane from mine pre-drainage and medium quality gob gas
- Use methane at near atmospheric pressure, avoiding compression costs
- Use methane diluted with air and/or carbon dioxide
- Generate electricity for distributed power generation systems
- Lower NO_X and SO_2 emissions, and virtually eliminate particulate emissions
- Reduce emissions of methane (a greenhouse gas)

Coal mine methane can be used in fuel cells to generate low cost power for mining operations, trimming overhead costs

WHY CONSIDER COAL MINE METHANE POWERED FUEL CELLS?

At present, fuel cells are economically competitive with conventional forms of electricity generation only in certain cases. Fuel cells are, however, making steady progress toward the goal of widespread commercial use. Use of methane in fuel cells, recovered from gassy coal mines, may be an economical approach to on-site power generation or local use.

Gob areas (collapsed rock over mined-out areas) release large volumes of gas and subsequently vent it to the atmosphere. Much of this gas is of medium quality and unsuitable for pipeline injection. However, fuel cells can operate on medium-quality gas, reducing methane emissions to the atmosphere while producing electrical power for on-site use. Because of their high efficiency, the use of fuel cells for power generation emits less carbon dioxide per kilowatt-hour of electricity produced than conventional turbine and internal combustion power generation methods. Sulfur and NO_x emissions are also low, making permitting easier and less expensive.

Powering fuel cells with coal mine methane provides economic benefits, as well as the environmental benefits already associated with fuel cells

Several hundred phosphoric-acid fuel cells (PAFCs) are now in use worldwide. In the United States, several small commercial and light industrial operations have begun using PAFCs during the past five years. PAFCs are reliable and can operate on conventional natural gas as well as coal mine methane. PAFCs that produce from 200 kW to 11 MW at 40 percent efficiency are now commercially available from International Fuel Cells.

Molten-carbonate fuel cells (MCFCs) are smaller than PAFCs, and testing indicates that they are more efficient. The US Department of Energy, in conjunction with the City of Santa Clara, has successfully tested MCFCs with a capacity of 200 kW to 2 MW. The U.S. Department of Energy plans to test MCFCs using gas produced from coal gasification, and coal mine gob gas. Commercial versions of these fuel cells should be available by 2001.

SOME FACTS ABOUT POWER GENERATION USING FUEL CELLS…

- Modular design allows for custom power generation and generation close to the load, reducing transmission and distribution losses
- Better efficiency than turbine generated power (efficiencies between 40-60%)
- A typical gassy mine can drain at least 1 mmcf of methane per day. A 200 kW PAFC unit would require about 80 mcf per day of medium heating value (50% methane) gas; a MCFC would require about 62 mcf per day

Coal mine methane lacks heavy hydrocarbons, making it better suited to fuel cell power production than natural gas

- Ideal power for industries located near coal mines producing medium to high heating value coal mine gas
- Short permitting and licensing schedules due to clean, quiet, safe operation
- Capable of using thermal output for heating (cogeneration), raising potential efficiency to over 80 percent
- Main by-product is purified water

COMPARISON OF PHOSPHORIC ACID AND MOLTEN CARBONATE FUEL CELLS

Parameter	*Phosphoric-acid Fuel Cells (PAFC)*	*Molten-carbonate Fuel Cells (MCFC)*
Typical operating costs ($US)	$0.0017/kWh	$9.8/kW/yr + $0.0017/kWh[1]
Typical capital costs ($US)	$2,250-3,750/kW	$1,000-1,500/kW[1]
Estimated total costs/kWh ($US)[2]	$0.0527-0.0873/kWh	$0.0256-0.0370/kWh
Typical efficiency	40-45%	50-60%
Operating temperature (°C)	200	650
Thermal output (Btu/kWh)	7,000-8,300	6,000-6,800
Oxidant requirements	Oxygen	Oxygen & Carbon dioxide[3]
Can use coal mine methane [4]	Yes	Yes
Fuel processor required	Yes	No
Commercial availability	Now	2001

[1]Estimated for commercial operation when available.

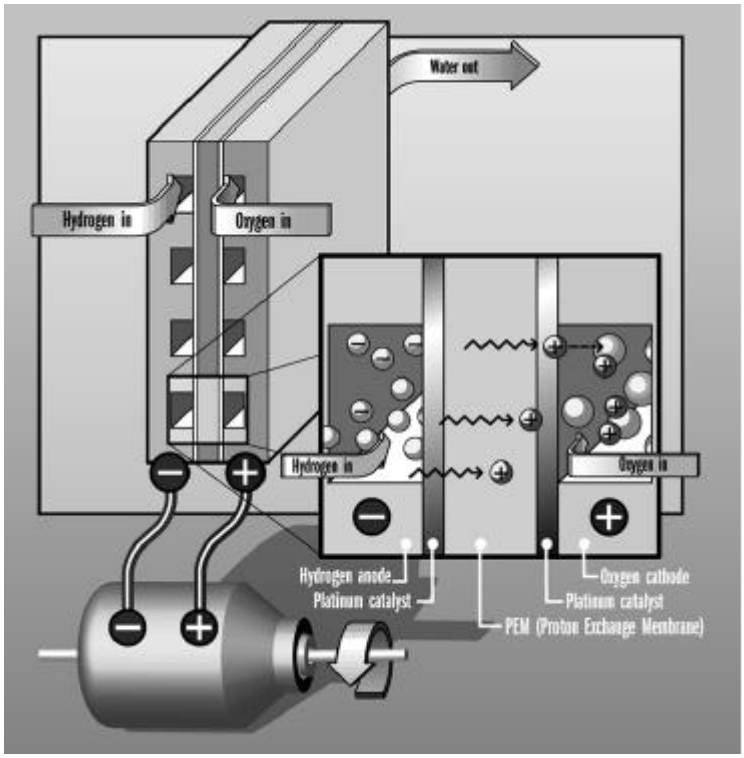
[2]Based on a 200 kW unit over a five year operation period at maximum capacity. Five years is the minimum expected life for the cell stacks. Technology is evolving rapidly and prices are expected to decrease.

[3]Fuel cells can use air as an oxygen source. Product gas can be a source of carbon dioxide.

[4]Either coal mining operations or "stand-alone" wells can provide coalbed methane for the process. Utilization of methane produced during coal mining operations is especially attractive because in most cases, mines vent the methane to the atmosphere, which contributes to global warming. Because mines would otherwise waste coal mine methane, it is typically less expensive than conventional natural gas.

USING COAL MINE METHANE IN FUEL CELL-POWERED VEHICLES

Proton exchange membrane (PEM) fuel cell technology has been refined during the past few years and used in a wide range of stationary and transportation applications. Since 1997, several urban transit buses in Vancouver, British Columbia and Chicago, Illinois have been powered by 275 HP Ballard Fuel Cell engines. These zero-emission engines use hydrogen reformed from natural gas or methanol to create electricity without combustion. The Fuelcell Propulsion Institute is currently developing fuel cells powered by hydrogen produced from coal mine methane for use in underground mine vehicles. Coal mine methane can play a key role in the production of hydrogen to fuel both stationary fuel cell power plants and fuel cell engines for vehicles.



How A Proton Exchange Membrane Fuel Cell Works

The underlying principle of the fuel cell is similar to that of a battery. Operating with a solid electrolyte at low temperature of approximately 80°C, hydrogen (H_2) and oxygen (O_2) are fed into the cell and an electrochemical reaction generates direct current. The only reaction product is water (H_2O).

For More Information…

Recent developments in fuel cell technology are expanding the options for coal mine methane use. Use of coal mine methane in fuel cells can increase mine profits while reducing methane emissions to the atmosphere.

To obtain more information about using coalbed methane in fuel cells for power generation, contact:

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Or contact U.S. EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane:

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